



Translation of Claims for Japanese Patent 5-124188

1. An ink-jet head comprising a nozzle plate having a plurality of nozzle apertures and a lamination type piezoelectric converter arranged behind said nozzle plate and capable of being independently driven, and in which recoding ink between the nozzle plate and the lamination type piezoelectric transducer is jetted, characterized in that an electric insulating oxide layer is formed on the surface and in the vacancy of the lamination type piezoelectric transducer.

2. 1. An ink-jet head comprising a nozzle plate having a plurality of nozzle apertures and a lamination type piezoelectric converter arranged behind said nozzle plate and capable of being independently driven, and in which recoding ink between the nozzle plate and the lamination type piezoelectric transducer is jetted, characterized in that an electric insulating oxide layer is formed on the surface and in the vacancy of the lamination type piezoelectric transducer by applying sol of which oxide particles are dispersed thereto.

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**CLAIMS**

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[Claim]

[Claim 1] The piezo-electric-crystal element for which it comes to form the low dielectric matter which is the piezo-electric-crystal element equipped with the lower electrode, the piezo-electric-crystal layer formed on the concerned lower electrode, and the upper electrode formed on the concerned piezo-electric-crystal layer, and equipped the grain-boundary exposed region of the aforementioned piezo-electric-crystal layer with the low dielectric constant from the concerned piezo-electric-crystal layer at least.

[Claim 2] The piezo-electric-crystal element to which the grain boundary of the crystalline of the aforementioned piezo-electric-crystal layer comes to exist in an abbreviation perpendicular direction to the aforementioned electrode side.

[Claim 3] The aforementioned piezo-electric-crystal layer is the claim 1 which it comes to constitute considering titanate-acid lead zirconate as a principal component, or a piezo-electric-crystal element given in two.

[Claim 4] A piezo-electric-crystal element given in any 1 term of the claim 1 whose thicknesss of the aforementioned piezo-electric-crystal layer are 0.5 micrometers or more and 5 micrometers or less, or the claim 3.

[Claim 5] The aforementioned low dielectric matter is a piezo-electric-crystal element given in any 1 term of the claim 1 which consists of a crystalline which does not have a perovskite type structure, or the claim 4.

[Claim 6] The piezo-electric-crystal element of the claim 3 publication whose structure expression of the aforementioned low dielectric matter is the pyrochlore structure of  $A_2B_2O_7$  (however, A contains Pb and B contains Zr and Ti) \*\*.

[Claim 7] The piezo-electric-crystal element of the claim 3 publication with the aforementioned amorphous low dielectric matter.

[Claim 8] The actuator which equipped any 1 term of the claim 1 or the claim 7 with the piezo-electric-crystal element of a publication as vibrator.

[Claim 9] The ink-jet formula record head equipped with the actuator of claim 8 publication.

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[Translation done.]

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DETAILED DESCRIPTION

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[Detailed description]

[0001]

[Field of the Invention] this invention makes record ink fly and relates to the ink-jet head and its manufacture technique of the ink-jet recording device which forms a character and a picture image.

[0002]

[Prior art] In order to make the minute ink drop which is a low running cost since the regular paper in which the high-speed record with easy color-izing whose process is an easy non-ambient noise since an ink-jet record is a direct record is possible can be used breathe out, it has the characteristic feature which was excellent in the grade which can record a high resolution, and the future attracts attention.

[0003] The stability of the ink drop which flew when the ink-jet head currently indicated by the Japanese Patent Publication No. 8953 [ 60 to ] official report etc. vibrated conventionally so that a variation rate may be carried out in the orientation in which a nozzle formation component and a piezoelectric transducer cross at right angles in general, and the passage between each nozzle passed in a short distance is good, and even when foreign matters, such as the foam and dust, mix into ink, it has the characteristic feature that an operation is normally maintainable, without these being influenced.

[0004] However, in an ink-jet head, although it is desirable that the regurgitation luminous efficacy and the flight force of a field to an ink drop of printing speed and a quality of printed character are large, the ink-jet head of the aforementioned structure is not enough as the amount of expansion and contraction per unit length of a piezoelectric transducer, or the amount of expansion and contraction per unit voltage, and the occurrence force is also the parvus. Therefore, in order to acquire the flight force required of a printing, the beam of a piezoelectric transducer was lengthened, or impression of a high voltage was needed, and there was a problem that a drive circuit and the cure against an electric insulation were complicated.

[0005] In order to solve such a problem, an internal electrode and a piezo electric crystal are piled up by turns, and the ink-jet head using the unified laminating type piezoelectric transducer is proposed as indicated by the Japanese Patent Publication No. 125343 [ 63 to ] official report etc. A laminating type piezoelectric transducer is adjusting the number of laminatings, does not drop the mechanical strength of a piezoelectric transducer, but can make small distance between layers of an internal electrode and an internal electrode as much as possible. Since thin-layer-ization of a piezo electric crystal has the effect which raises field strength, large low-battery-ization of a driver voltage is attained.

[0006]

[Object of the Invention] However, since the ink-jet head using the conventional laminating piezoelectric transducer mentioned above of the cutoff with ink is inadequate when the laminating type piezoelectric transducer itself is directly in contact with ink or it is intercepted, it will be limited to the ink with the electric insulation to use. Therefore, since priority was given to an electric insulation, it had the technical problem that it could not satisfy enough a high quality of printed character and a quick-drying one, by limiting record ink.

[0007] Especially, the metal which makes silver and silver-palladium a principal component is used for the internal electrode material of a laminating type piezoelectric transducer, and it was easy to generate failure of the creeping discharge by the electromigration phenomenon, \*\*\*\* electric discharge, etc., and in spite of having not touched, in connection with presence of the humidity near an electrode, or high-density-izing of temperature and internal inter-electrode distance, it had the technical problem whose piezoelectric transducer touches ink that the aforementioned phenomenon was promoted.

[0008] Moreover, since a laminating type piezoelectric transducer sinters the ceramic powder and metal paste which contained the organic component so much and is manufactured, an organic component escapes from it after sintering, and it serves as the perforated space containing a detailed breakthrough (this hole is called hole). Therefore, the aforementioned phenomenon has possibility of generating also not only in the front face of a piezoelectric transducer but in the interior.

[0009] Then, the purpose of this invention solves these technical problems, makes all ink fly stably, and is to offer the ink-jet head which can attain high-speed and high definition printing and high-reliability, and its manufacture technique.

[0010]

[The means for solving a technical problem] The ink-jet head of this invention has the nozzle plate which has two or more nozzle openings, and the laminating type piezoelectric transducer which has been arranged behind this nozzle plate and which can be driven independently, and is characterized by forming the oxide layer of an electric insulation in the front face and hole of a laminating type piezoelectric transducer in the ink-jet head which makes the record ink between a nozzle plate and a laminating

type piezoelectric transducer breathe out.

[0011] Moreover, it is characterized by the manufacture technique of the ink-jet head of this invention forming the oxide layer of an electric insulation by applying the sol which the oxide particle distributed to the front face and hole of a laminating type piezoelectric transducer in the manufacture technique of an ink-jet head of having the nozzle plate which has two or more nozzle openings, and the laminating type piezoelectric transducer which has been arranged behind this nozzle plate and which can be driven independently, and making the record ink between a nozzle plate and a laminating type piezoelectric transducer breathing out.

[0012]

[Operation] According to this invention, since the oxide layer of an electric insulation is formed in a piezoelectric-transducer front face and a hole, the electric insulation of a piezoelectric transducer improves and dielectric breakdown is suppressed. Furthermore, in order to converge quickly the deck watertight luminaire by the oxide layer, damp-proof and heat-resistant enhancement, and the residual vibration of a laminating piezoelectric transducer, the stability of an oscillation characteristic can also be raised.

[0013]

[Example] Drawing 1 is the tropia cross section of the important section of an ink-jet head in this invention. A piezoelectric transducer 10 is the multilayer structure which accumulated a piezo electric crystal 11 and the electric conduction material 12a and 12b (the internal electrodes 12a and 12b are called hereafter.), such as a piezoelectric ceramics, by turns, respectively. Furthermore, the electric conduction material 14a and 14b (the external electrodes 14a and 14b are called hereafter.) is formed in the piezoelectric transducer 10, and, as for external electrode 14a, the electric conduction is made with internal electrode 12b, respectively, as for internal electrode 12a and external electrode 14b. As shown in drawing 3, the oxide layer 13 of an electric insulation is formed in surface 10a and hole 10b of a piezoelectric transducer 10 by the technique of mentioning later. Moreover, the piezoelectric transducer 10 is joined on the base component 15.

[0014] In such a configuration, the piezoelectric transducer 10 to which the electric field shown in drawing 2 when an electrical signal of operation is inputted into a piezoelectric transducer 10 were impressed is contracted in the orientation which intersects perpendicularly with a nozzle plate 16. If this electric field are canceled, according to the elastic stability of a piezoelectric transducer 10, a pressure will be applied to the ink 17 between nozzle plates 16, and an ink drop will carry out the regurgitation from the nozzle opening 18.

[0015] The manufacture technique is described below.

[0016] After applying to a piezoelectric-transducer front face fundamentally the organosol which made the organic solvent the primary-dispersion solvent for nonmetallic oxides, such as metallic oxides, such as aluminum, titanium, and a zirconium, and silicon, or those conjugated compounds as a dispersoid, the oxide layer of an electric insulation is formed in a piezoelectric-transducer front face and a hole by evaporating and drying a solvent. (Example 1)

The SiO<sub>2</sub>-ZrO<sub>2</sub>= weight ratio 65:35 used for the front face and hole of a piezoelectric transducer 10 20% of the solid contents which distributed ethanol to the dispersion medium made into a principal component, viscosity 7cP (centipoise), and the sol of 0.01 micrometers of mean particle diameters as an example 1.

[0017] First, a piezoelectric transducer 10 and the above-mentioned sol are separately installed in a pressurized container. The inside of a pressurized container is decompressed gradually, it goes, and a piezoelectric transducer 10 is immersed in a sol in the state of equilibrium pressure. And air is put in in a pressurized container, sealing of the hole is carried out to the front face of a piezoelectric transducer 10 using atmospheric pressure, and covering and restoration are carried out.

[0018] The technique and the spin coat which are immersed only in atmospheric pressure, without carrying out reduced pressure processing at a method of application after immersing a piezoelectric transducer 10 in the above-mentioned sol otherwise, and carrying out pressure operation, and a dipping are sufficient.

[0019] Next, desolventization processing of a sol is carried out. The solvent of the sol which heated and filled up the piezoelectric transducer with 80 degrees C is volatilized. SiO<sub>2</sub>-ZrO two-layer is formed in the front face of a piezoelectric transducer 10 of this.

[0020] If the above-mentioned immersing operation and stoving operation are repeated by turns, paint film defects, such as a pinhole, are lost, and the gas cutoff nature of a piezoelectric transducer 10 can improve further, and can obtain a desired thickness (0.1 micrometers - several 100 micrometers).

[0021] As a result of making drainage-system color ink breathe out by this example using the head which repeated the above-mentioned operation 3 times, insulation-ized the front face of a piezoelectric transducer by 0.6-micrometer SiO<sub>2</sub>-ZrO two-layer, and was manufactured, the ink regurgitation by which it was stabilized more than 5 million line (1 billion dots) was possible.

[0022] (Example 2) The alumina particle used for the front face and hole of a piezoelectric transducer 10 10% of the solid contents which distributed the isopropanol to the dispersion medium made into a principal component, viscosity 5cP (centipoise), and the alumina sol of 0.05 micrometers of mean particle diameters as an example 2.

[0023] First, it was immersed only in atmospheric pressure, without carrying out pressure operation, the piezoelectric transducer was heated at 80 degrees C, the solvent was volatilized, and the alumina layer was formed in the piezoelectric-transducer front face.

[0024] As a result of repeating the above-mentioned operation twice, insulation-izing the front face of thick \*\*\*\*\* in a 0.5-micrometer alumina layer and making the hot-melt ink always heated at 110 degrees C breathe out using the manufactured

head, the ink regurgitation by which it was stabilized more than 5 million line (1 billion dots) was possible.

[0025] (Example 3) The SiO<sub>2</sub>-ZrO<sub>2</sub>-Na<sub>2</sub>O particle used for the front face and hole of a piezoelectric transducer 10 5% of the solid contents which distributed ethanol to the dispersion medium made into a principal component, viscosity 10c (centipoise), and the sol of 0.02 micrometers of mean particle diameters as an example 3.

[0026] First, the above-mentioned sol was applied on the surface of the piezoelectric transducer by the dipping, it heated at 120 degrees C, the solvent was volatilized, and the SiO<sub>2</sub>-ZrO<sub>2</sub>-Na<sub>2</sub>O layer was formed in the thick \*\*\*\*\* front face.

[0027] As a result of repeating the above-mentioned operation 4 times, insulation-izing the front face of thick \*\*\*\*\* by 0.8-micrometer SiO<sub>2</sub>-ZrO<sub>2</sub>-Na<sub>2</sub>O layer and making the solvent ink which made the aliphatic hydrocarbon (tradename Isopar L, Exxon company make) of the high boiling point and a low volatility distribute a pigment breathe out using the manufactured head, the ink regurgitation by which it was stabilized more than 5 million line (1 billion dots) was possible.

[0028]

[Effect of the invention] According to this invention, it has the nozzle plate which has two or more nozzle openings, and the laminating type piezoelectric transducer which has been arranged behind this nozzle plate and which can be driven independently. In the ink-jet head which makes the record ink between a nozzle plate and a laminating type piezoelectric transducer breathe out. By forming the oxide layer of an electric insulation in the front face and hole of a laminating type piezoelectric transducer, it has the effect that a piezoelectric transducer can be perfectly intercepted from mixing of foreign matters, such as moisture and dust, contamination, disturbance, etc.

[0029] Moreover, there is no electric-insulation resistance degradation of a piezoelectric transducer, and it also has the effect of making possible the regurgitation which has endurance in a long period of time.

[0030] Moreover, since it can be stabilized and all the ink of drainage-system ink, solvent ink, and hot-melt ink can be made to breathe out, it also has the effect that a quantity quality of printed character and a high definition ink-jet head can be offered.

[0031] Furthermore, it also has the effect of offering the piezoelectric transducer excellent in thermal resistance.

[0032] Furthermore, since the residual stress of a piezoelectric transducer can be converged quickly, it also has the effect which raises the stability of an oscillation characteristic by leaps and bounds.

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